United States
Environmental Protection Agency
401 M Street, SW. (5305W)
Washington, DC 20460

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Solid Waste and Emergency Response (5305W)

EPA

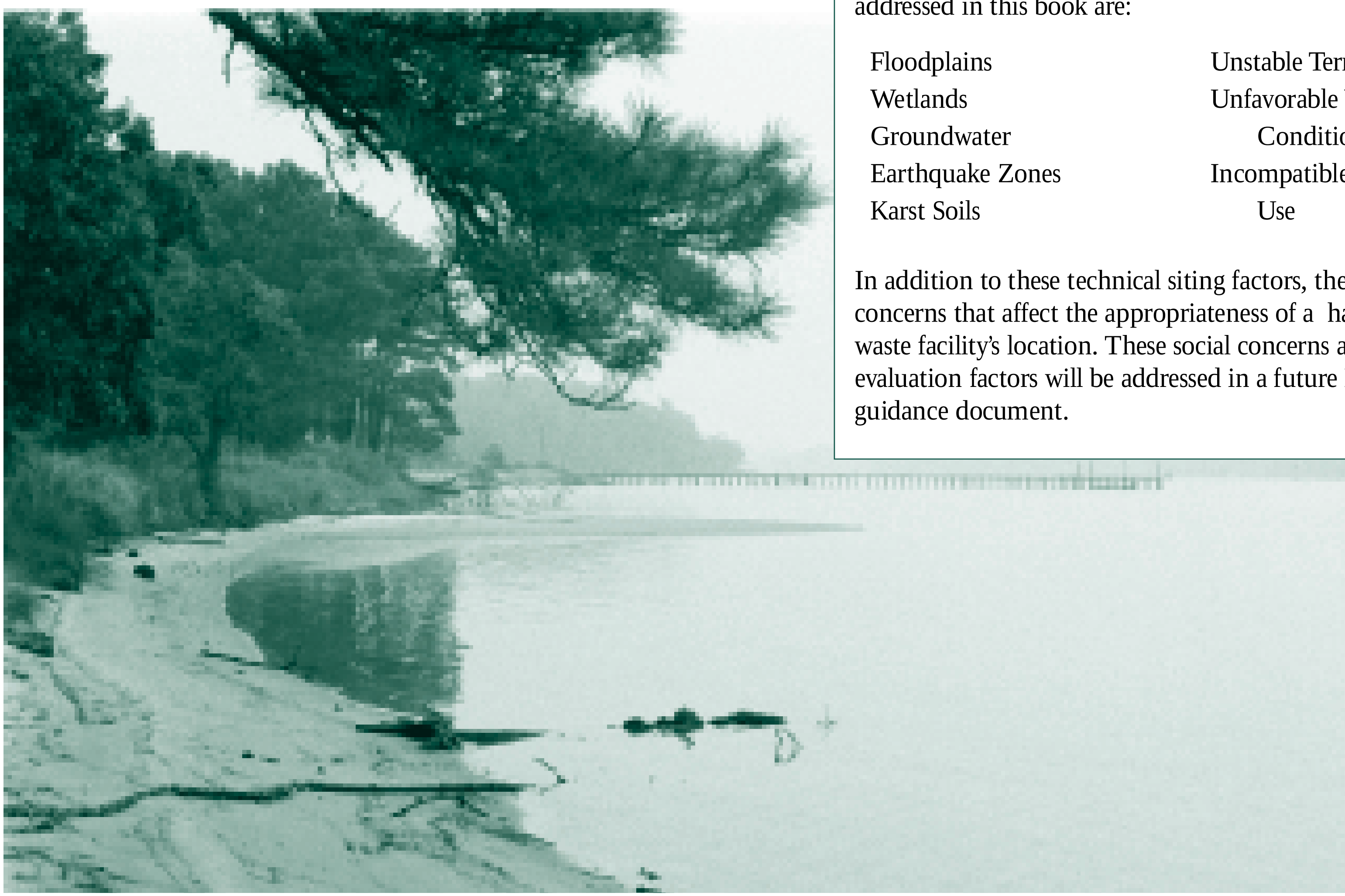
Sensitive Environments and the Siting of Hazardous Waste Management Facilities

Introduction

This publication discusses sensitive types of environments that pose special challenges to the siting, expansion, and operation of RCRA hazardous waste management facilities. Locating hazardous waste management facilities in certain areas – because of their soils, terrain, groundwater, or weather conditions – may pose significant risks of releases and possible exposures to humans and the environment. The environmentally sensitive locations addressed in this book are:

- Floodplains
- Wetlands
- Groundwater
- Earthquake Zones
- Karst Soils
- Unstable Terrain
- Unfavorable Weather Conditions
- Incompatible Land Use

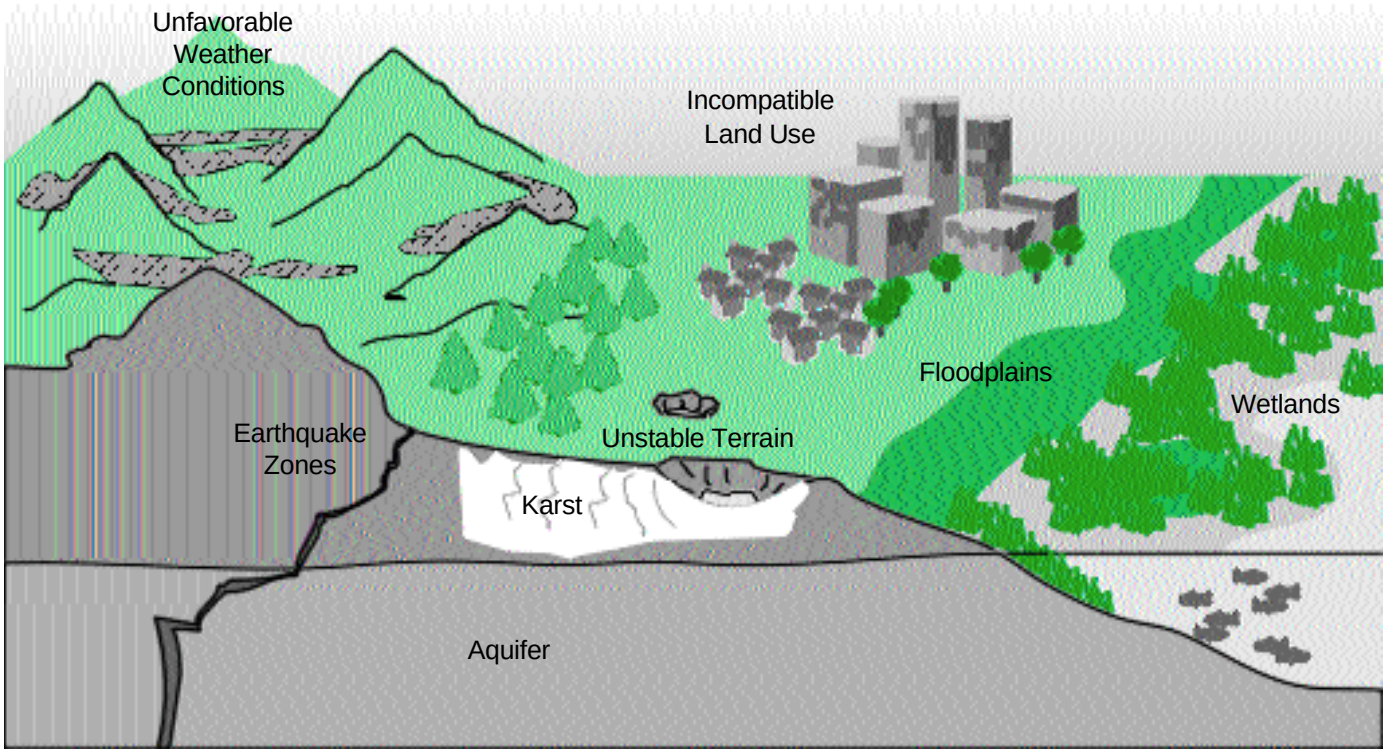
In addition to these technical siting factors, there are social concerns that affect the appropriateness of a hazardous waste facility's location. These social concerns and related evaluation factors will be addressed in a future EPA guidance document.



Corel Corporation

What Are Environmentally Sensitive Locations and Why Are They a Concern?

Sensitive environments are locations that, because of their physical conditions, may be disturbed or permanently damaged by hazardous waste contamination. Wetlands, for example, are especially sensitive to chemical contamination. Sensitive environments are also locations that are physically unstable and may change so greatly that they can cause the release of a hazardous waste or complicate its cleanup.



Locating hazardous waste facilities in the sensitive environments shown in this figure increases the risk of contamination.

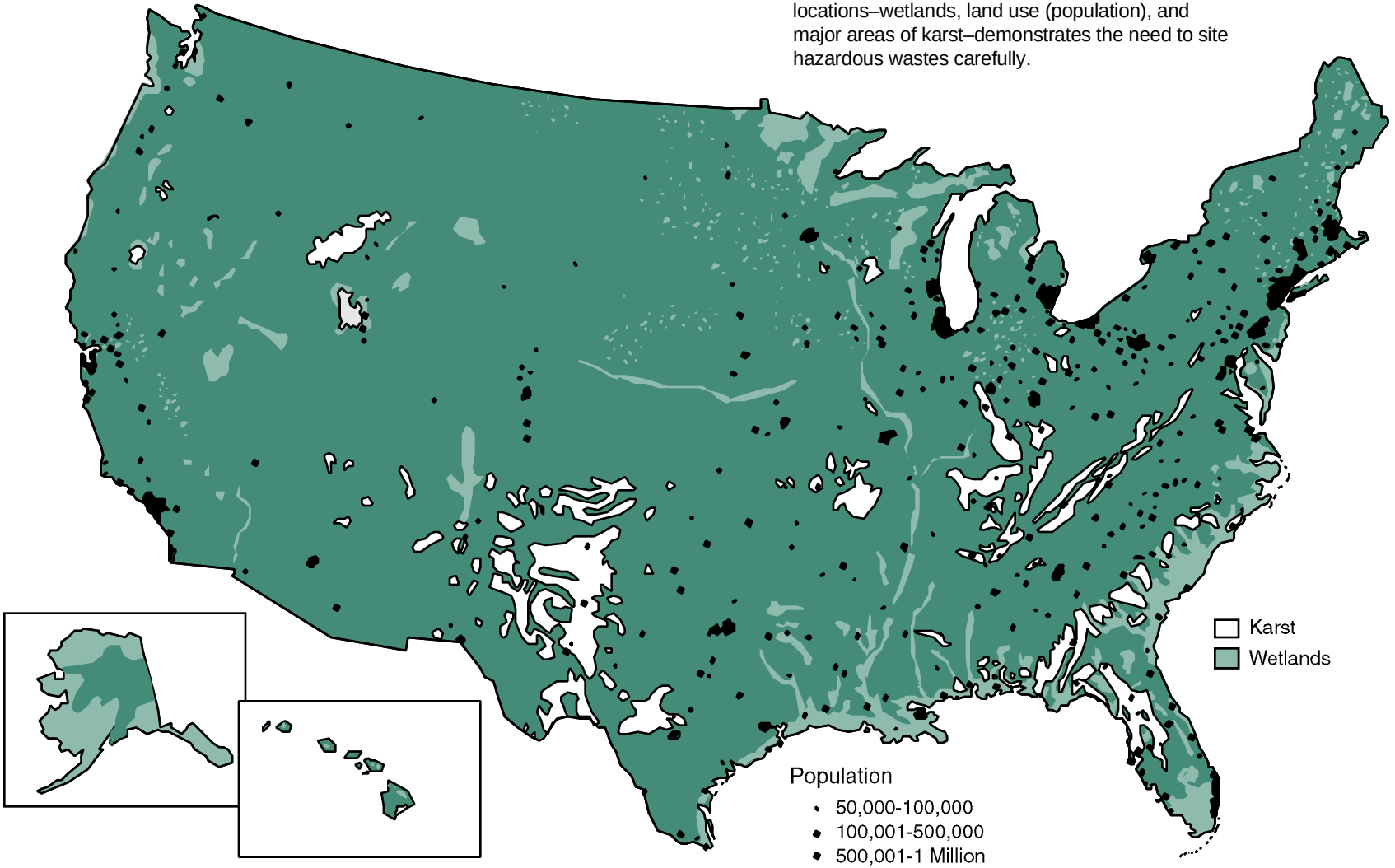
For example, floodwaters spilling into floodplains may damage waste management structures such as tanks or berms (walls of earth), causing the release of hazardous waste to the environment. This brochure provides additional information on wetlands and floodplains and discusses other environments that are sensitive, particularly in relation to hazardous waste management facilities.

Soil, groundwater, and weather conditions are important technical factors in determining how environmentally sensitive a location is. Knowing about environmentally sensitive areas helps ensure that a hazardous waste management facility is sited at a location that is safe for our health and our environment. For example, facilities constructed on unstable ground or in floodplains are at greater risk for landslides or floods, respectively, which could cause accidental hazardous waste releases. Therefore, when selecting a location for a hazardous waste facility, such safety concerns must be considered.

Other nontechnical factors to consider in locating a hazardous waste management facility are the people living and working around the facility, that is, the number of people, their ages, and their health. Also, hospitals and schools should be considered because they may be difficult to evacuate in the event of a hazardous waste spill. This is why many states require hazardous waste management facilities to locate a safe distance from densely populated areas, hospitals, schools, or prisons. These issues will be discussed in further detail in an upcoming companion brochure on social factors.

Companies that plan to construct and operate hazardous waste management facilities should avoid siting their facilities in environmentally sensitive areas. If a company does decide to locate a facility in a sensitive area, its owner should design the facility to minimize risks to people and the environment. By law, an owner's approach to locating a safe hazardous waste management facility must include consideration of the physical site, the facility's design, and its operating conditions. The facility's design includes such factors as whether it is designed to protect surrounding soils and groundwaters. Operating conditions may include how many hours each day an incinerator may burn waste and how well a technology destroys or treats waste.

The distribution of three of the types of sensitive locations–wetlands, land use (population), and major areas of karst–demonstrates the need to site hazardous wastes carefully.



Floodplains

Floodplains are lands that are subject to periodic flooding. They are usually lowlands along rivers, streams, lakes, and oceans. Often, they occur where annual water flow is low or nonexistent, but they may also occur due to large amounts of melting snow or rainfall that run off the land.

Facts About Floodplains

Floodplains act as natural storage areas, slowing down rushing floodwaters and reducing downstream flooding. Floodplains also help maintain the quality of rivers and streams by filtering eroded soils (also known as sediments) and nutrients such as nitrogen and phosphorus.

To Learn Where Floodplains are Located . . .

Floodplain maps can be obtained at no cost from the Federal Emergency Management Agency's Flood Map Distribution Center, 6930 (A-F) San Tomas Road, Baltimore, MD 21227-6227 or from the U.S. Army Corps of Engineers, the Soil Conservation Service, the National Oceanic and Atmospheric Administration, the US Geological Survey, the Bureau of Land Management, the Bureau of Reclamation, the Tennessee Valley Authority, and State and local flood control agencies. Your county or city planning office should also have floodplain maps. Know your local zoning laws!

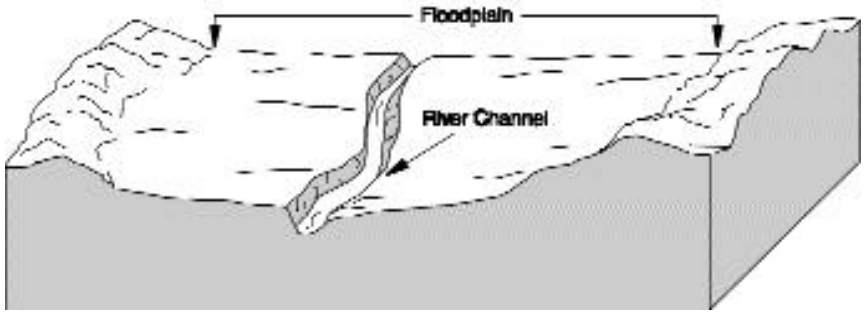
What is a 100-Year Floodplain?

A 100-year floodplain is any land area that is subject to a 1 percent or greater chance of flooding in any given year from any source.

The Problem with Locating a Facility in a Floodplain

Industry considers floodplains as valuable locations for development because they are often flat and near water and transportation routes. However, EPA has recently seen the damage that flooding can cause at hazardous waste management facilities (for example, the 100-year and 500-year floods that have occurred along the Mississippi River). In some cases, floodwaters have floated hazardous waste storage tanks off their foundations and floodwaters have flowed into waste ponds, carrying their hazardous contents downstream.

The speed of flood waters is also a concern because high flow rates can erode wastepiles, berms, landfills, or other types of waste management structures.



Floodplains are typically lands along waterways that may flood.

Facility Siting Recommendations

Facilities should avoid building in floodplains. Existing regulations require hazardous waste management structures built in a 100-year floodplain to be built above the 100-year flood level or built to withstand the flooding event. See Title 40 of the Code of Federal Regulations, Section 264.18 (40 CFR 264.18).

Facilities can be declared exempt from this regulation if they prove (1) that they can remove all waste before the flood or (2) no harm will come to human health or the environment when the flood occurs. Regulations also allow facilities to locate in 100-year floodplains if owners can prove that the facility can withstand a washout in the event of a flood (40 CFR 270.14(b)(11)(iv)). In addition, all facilities should have detailed, up-to-date emergency response plans that can be put into action before and during floods. Check your state and local regulations; they may have more stringent requirements that also have to be met.

Wetlands

Wetlands are areas that are waterlogged for an extended period of time and include a variety of fish and wildlife habitats. Swamps, marshes, bayous, bogs, and Arctic tundra are wetlands. Wetlands are highly sensitive areas that are among the most productive ecosystems in the world.

Interesting Facts about Wetlands

- One-third of all bird species appear in wetlands, which serve as vital migratory resting, staging, and nesting areas for waterfowl and other species.
- 96 percent of all fish species caught by commercial fishers depend upon wetlands for part of their life-cycle.
- Wetlands control shoreline erosion, which protects other ecosystems from storms, improves water quality, supplies water, and regulates climates.

The Problem with Locating a Facility In or Near Wetlands

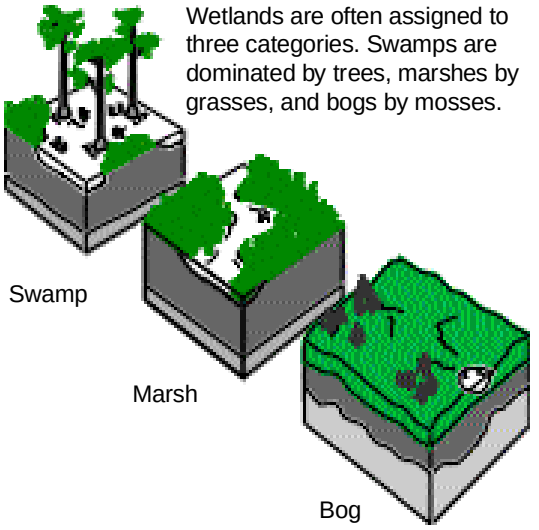
Construction or expansion of hazardous waste management facilities directly in and near wetlands can destroy fish and/or wildlife habitats. In addition, the high amounts of unstable soils and water in wetlands make them poor areas for land-based hazardous waste structures such as landfills.

Any hazardous wastes spilled on wetlands can spread faster through the groundwater and surface water. Such contamination may harm commercial and recreational fisheries and shellfish harvesting. Eating finfish and shellfish that have accumulated toxic substances can be dangerous to human health. Hazardous waste releases into wetlands can also reduce the variety and reproduction of species living in wetlands.

One of the most serious consequences of a hazardous waste spill or leak in a wetland can occur in the process of restoring the wetland. Removing the contaminated sediments can be very costly and may even destroy the wetland. Because wetlands are typically found at the headwaters of rivers, lakes, and streams, removal of contaminated bottom sediments in wetlands could unintentionally release contaminants downstream to unsuspecting human, fish, and wildlife populations.

Facility Siting Recommendations

Hazardous waste management facilities should not be located in wetlands. This strategy of no construction in wetlands supports the EPA's goal of no net loss of this important resource. Facilities planning to locate near wetlands should also take special protective steps. They should (1) investigate how the soil and groundwater would be affected by spilled hazardous wastes, and (2) design the facility to prevent spills.



Wetlands are often assigned to three categories. Swamps are dominated by trees, marshes by grasses, and bogs by mosses.

Highlights of Wetlands Protection Laws

Section 404 of the Clean Water Act (CWA) requires permits from the Army Corps of Engineers for activities involving the discharge of dredged or fill materials into "waters of the United States," which include wetlands. Other laws that provide some protection to wetlands are: the Wild and Scenic Rivers Act, the Fish and Wildlife Coordination Act, the Endangered Species Act, and the Coastal Zone Management Act. In addition, some States are now enacting wetlands protection laws.

Groundwater

Groundwater is a collection of water beneath the earth's surface that is fed either by rainfall percolating through soil and rock or by surface water. High-value groundwater is (1) the sole source of drinking water available, or (2) the water feeding into a sensitive environment such as a wetland.

Hydrogeology is the study of the interaction between groundwater and its source (soil, surface water) along with its movement. A site's hydrogeology is considered complex when scientists cannot accurately characterize, monitor, or predict groundwater movement.

Interesting Facts About Groundwater

- Over half the U.S. population uses groundwater as its main drinking water source.
- 95 percent of rural households rely on groundwater for their drinking water.
- Groundwater is the only source of drinking water for people in some areas.
- 34 of the 100 largest U.S. cities rely on groundwater for drinking and commercial purposes.

Julie Fountain

The Problem with Locating a Facility Near High-Value Groundwater

In certain parts of the country, contaminants can move quickly into the groundwater. It can be very difficult and expensive, if not impossible, to clean up this contamination. The underground soil and rock in certain areas make it difficult for scientists to find out the direction of groundwater flow, which further complicates cleanup. Most of the time, groundwater cannot be cleaned for a reasonable cost and within a reasonable time frame. Removing contamination from groundwater may take hundreds of years.

Facility Siting Recommendations

Experts believe that hazardous waste management facilities should not be located over high-value groundwater or areas where the underground conditions are complex and not understood. If a facility plans to locate in one of these areas, EPA requires several studies as part of the groundwater investigation, such as (1) determining the complexity and importance of the groundwater for drinking supplies, (2) determining the direction of groundwater flow, (3) assessing the ability of the groundwater to be replenished, and (4) determining how other waters (e.g., rivers and wetlands) are connected to the groundwater.

Facility owners should also take extra steps to make sure that no leaks or spills will occur from structures that hold hazardous wastes. They should use conservative assumptions when engineering waste management structures such as adding more spill containment systems around structures. Also, the number of monitoring wells used to detect spills in these environments may need to be increased and samples taken more frequently.

Earthquake Zones

Earthquake zones are areas affected by earthquakes. Earthquakes are a significant threat to public safety and welfare over many parts of the United States, particularly the West Coast, Alaska, parts of the Rocky Mountains, the Mississippi Valley, and selected areas along the Eastern Seaboard.

The Problem with Locating a Facility in an Earthquake Zone

EPA is concerned about earthquakes affecting hazardous waste management facilities because they can damage structures that hold wastes and result in accidental releases to groundwater, surface water, soil, and air. Damage can result from movement of large pieces of ground or, more commonly, ground shaking. Because structures that hold hazardous waste (e.g., landfills, ponds, or lagoons) are often made of soil and rock, they can be damaged by earthquake activity. Structures above the ground, such as tanks and incinerators can also be damaged, toppled, or destroyed.

When is an Earthquake Zone a Siting Concern?

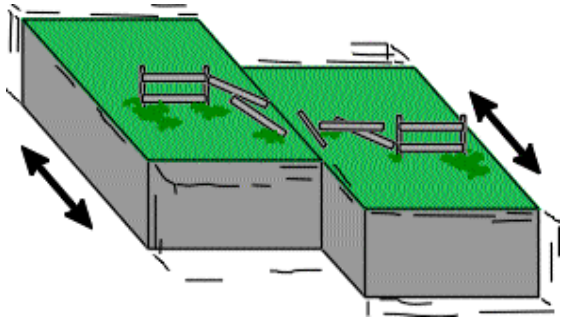
The magnitude or amount of ground shaking at a site is a good measure for determining if a site is appropriate for a hazardous waste management facility. To help determine the level of risk from shaking, scientists have mapped out seismic impact zones. These zones measure the amount that the ground could potentially shake during an earthquake. The risk is based on the area's geology and past earthquake activity. Maps of seismic impact zones are available to the public through the U.S. Geological Survey (USGS) and state and local governments.

Facility Siting Recommendations

EPA currently has regulations designed to prevent damage to hazardous waste management facilities in areas with earthquake activity. In Title 40 of the *Code of Federal Regulations*, Section 264.18(a) bans facilities from siting new hazardous waste management units within 200 feet of a Holocene fault (that is, faults that have been active within the last 10,000 years). These faults are located in certain areas of the western United States. And 40 CFR 270.14(b)(11)(ii) also requires owners and operators of hazardous waste management facilities to investigate Holocene faults that are within 3,000 feet of a facility.

In addition to the regulatory requirements, earthquake experts recommend a number of safety features for facilities in areas where earthquake activity can cause ground shaking or ground rupture:

- Design structures at hazardous waste management facilities to resist ground motion or shaking and withstand the maximum horizontal acceleration – the highest acceleration value expected at the earth's surface in that particular area. It has been found that the horizontal direction of shaking is much more damaging to structures than the vertical direction.
- Build structure containment systems to prevent spills in case of a failure.
- Pay special attention to site factors such as soil moisture and slope stability, which may enhance ground shaking and lead to structural failure.



The side-to-side motion of the ground during earthquakes causes the most damage to structures.

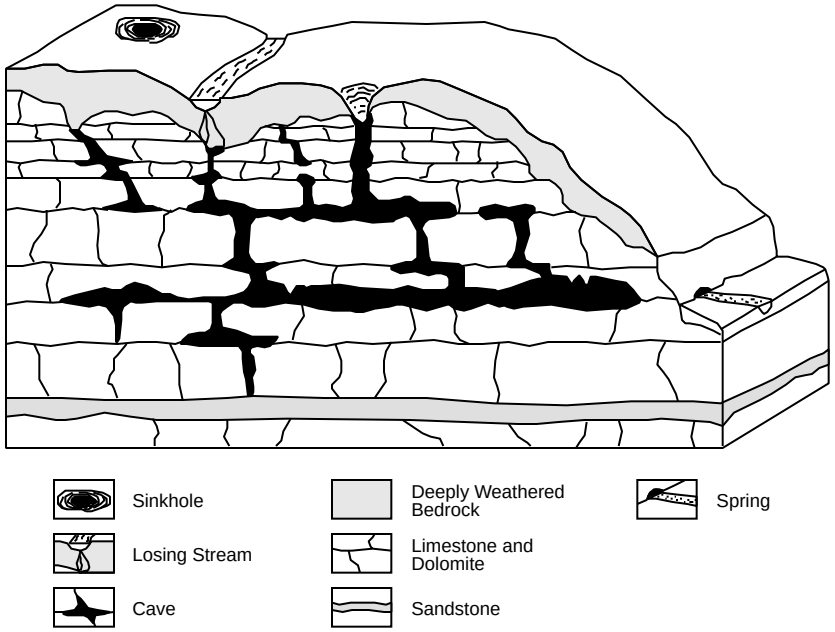
Karst Terrain

Karst terrain consists of rock – such as limestone, dolomite, or gypsum – that slowly dissolves when water passes through it. The dissolving rock leaves underground voids, tunnels, and caves. Sometimes these underground spaces can grow so large that their "ceilings" will collapse, forming large sinkholes.

A karst sinkhole in east-central Missouri.

The Problem with Locating a Facility in Karst Terrain

Facilities located in karst areas may have an increased chance of hazardous waste spills because sinkholes can form suddenly. These spills can contaminate the groundwater and make it difficult to clean up since the hydrogeology is complex in these areas. Engineers do not have good methods to protect hazardous waste management facilities against sinkhole collapse.



Karst soils are poor foundations for any structure.

Facility Siting Recommendations

Hazardous waste management facilities should avoid locating in “active” karst areas. Approximately 5 percent of the United States has “active” karst, including Missouri, Kentucky, Florida, Indiana, Arkansas, and Puerto Rico. Companies planning to locate facilities in karst areas should demonstrate that they can (1) engineer a waste management structure that protects against sinkhole formation (e.g., additional foundation support) and, in turn, hazardous waste spills, and (2) monitor and clean up groundwater contamination if it occurs. It is important that companies conduct site characterization studies in which they map sinkholes and underground caverns, determine ground stability, and measure the speed and direction of groundwater flow.

Unstable Terrain

Unstable terrain is any area where movement of the land surface can damage structures and buildings. Unstable terrain is divided into two kinds of land movement: (1) the movement of rock and soil on steep slopes by gravity (e.g., landslides), and (2) rock and soil sinking, swelling, or heaving.

The Problem with Locating a Facility on Unstable Terrain

EPA is concerned that movement of unstable soils can damage hazardous waste facilities and lead to spills and leaks. Mass movement of rock and soil onto a hazardous waste facility can crush or destroy buildings, puncture and bury drums of hazardous waste, and break apart earthen structures containing liquid wastes. Poor foundation conditions can:

- Cause buildings to shift and crack
- Disrupt landfill gas and leachate collection
- Rip landfill liner systems.

Damages such as these may cause hazardous waste spills that can be difficult to clean up.

Facility Siting Recommendations

Unstable terrain is found throughout the United States. Therefore, companies seeking locations should check for past mining activities, flood control, or groundwater withdrawal, which could cause the ground to sink. Natural conditions, such as high water content in soil and freezing temperatures that cause soil to heave or swell, should also be identified along with slumping soils caused by steep slopes that have high soil moisture, poor drainage, or weak soils.

It is possible to build a safe facility on unstable terrain; however, construction and operating costs would increase considerably. Although most of the risks to facilities in unstable terrains can be addressed by good design and engineering, EPA recommends that facilities perform geotechnical analyses of soil and geologic properties to determine the extent of unstable conditions. This information will help a facility decide if its unit should be located in another area or if additional design and engineering measures are needed.

U.S. Geological Survey

Building on unstable soils can lead to serious environmental consequences.

Unfavorable Weather Conditions

Certain areas of the United States have atmospheric conditions that increase the chance of breathing air contaminants. Some parts of the country may have long periods with little or no air movement (such as Los Angeles' smog inversions). In these areas, air contaminants are not easily dispersed. In mountainous areas, air contaminants can also become trapped for a long time. This situation occurs because mountains can affect regional wind patterns by acting as barriers that reduce air flow.

The Problem with Locating a Facility in an Area with Unfavorable Weather Conditions

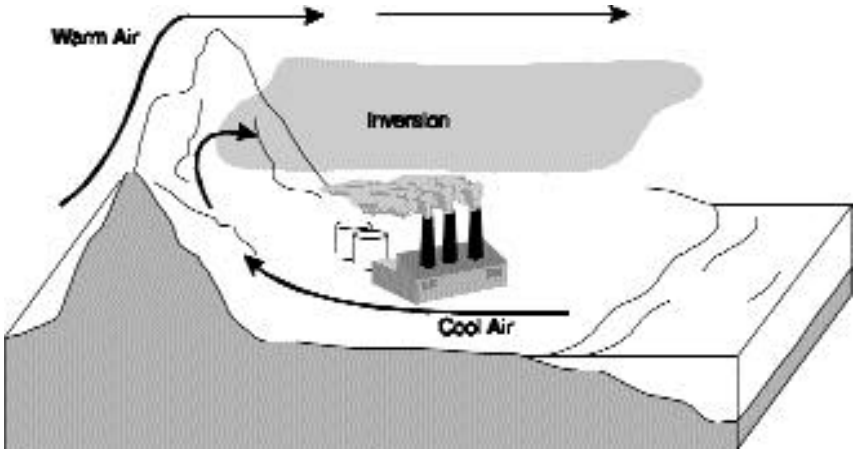
Hazardous waste management facilities increase the chance of exposing people and the environment to air contaminants in areas where stagnant weather conditions exist. Young and elderly people, along with people suffering with respiratory ailments, are more susceptible to extended exposures to air contaminants. In addition, eating food produced in areas with air pollutants (e.g., meat, milk, and grains) becomes a concern because these pollutants may be taken up by plant or animal respiration or by contaminated rainfall. Hazardous waste facilities that burn or incinerate waste (i.e., combustion facility, incinerator) may cause unacceptable contamination and, in turn, environmental exposures in these stagnant areas.

Facility Siting Recommendations

Facilities that burn hazardous wastes should avoid locating where unfavorable weather conditions exist. Atmospheric conditions in this type of area should be evaluated carefully by the facility. Facilities should evaluate the distribution and age of the population and other vulnerability factors and the effects of land features on wind patterns and pollutant mixing in the air. Seasonal effects on wind patterns should also be evaluated. Special engineering and placement of the facility at the site may be necessary to ensure acceptable dispersion of air contaminants. The permit for the facility may also need to restrict the operations of the facility to times when weather conditions are favorable.

Regulations Controlling Air Emissions from Hazardous Waste Management Facilities

Both the Clean Air Act and the Resource Conservation and Recovery Act contain regulations on the control of air pollution from hazardous waste facilities (40 CFR 264, Subparts I, J, K, and O and 40 CFR 266, Subpart H). Combustion regulations address specific chemical pollutants; tank, container, and waste pond regulations address volatile organic pollutants as a class. However, both sets of regulations target emission reduction. They do not address the siting of emission sources.



An inversion can be worsened by a mountain range forcing warm desert air to move up and over cooler ocean air flowing in the opposite direction.

Incompatible Land Use

Certain preexisting land uses may not be compatible with the operation of a hazardous waste management facility. For example, densely populated areas or facilities such as hospitals, schools, and prisons are especially vulnerable to hazardous waste exposures.

Human Exposure to Hazardous Wastes

People may become exposed to hazardous waste contaminants by breathing, drinking water, eating food, eating dirt (children, particularly), or by skin contact (with soil, air, or water).

The Problem with Locating a Facility Near Sensitive Populations

Certain people may be more sensitive to exposure to hazardous waste than the average person. Studies have shown that children and the elderly may be more sensitive to certain toxic substance exposures. Likewise, people who are sick can also be more vulnerable to toxic exposures, and their illnesses may become worse.

Facility Siting Recommendations

Hazardous waste management facilities should avoid locating near sensitive populations or in densely populated areas. Areas near schools, nursing homes, day care centers, or hospitals should be avoided. Many states have setback distances that prescribe the minimum distance a hazardous waste facility can be from certain types of land use. These minimum distances are meant to protect the public or the environment from potential exposure to hazardous waste.

EPA recommends NOT siting hazardous waste facilities in sensitive locations for the following reasons:

Location	Environmental Consequences
Floodplains	Waste ponds may wash out. Tanks may be moved from foundations.
Wetlands	Fish and wildlife are threatened. Spills are spread to groundwater and surface waters faster. Cleanup is difficult, costly, and sometimes more damaging.
Land Use	Sensitive populations such as the elderly, children, and the sick are more affected by toxic exposures.
High-Value Groundwater	Contaminants are transported quickly. Cleanup is costly and difficult.
Earthquake Zones	Ground fractures and shaking damage structures, leading to spills.
Karst Terrain	Sinkholes may develop, leading to structure failure and spills.
Unstable Terrain	Soil movement can shift and damage structures causing waste releases.
Unfavorable Weather Conditions	Stagnant air concentrates pollutants. Mountains may block pollutant dispersion.

For Further Information . . .

For further information on sensitive environments, please contact the RCRA hotline at 800-424-9349 or TDD-800-553-7672. In the Washington, DC, area, call 703-412-9810.

This publication is also available on the Internet at http://www.epa.gov/epaoswer/hazwaste.